TISSUE MANUFACTURING FROM ORGANIC WASTE : THE EFFECT OF DRYING TIME AND CHEMICAL TREATMENT

Compiled as requirement to obtain Bachelor Degree in Chemical Engineering Department Faculty of Engineering

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UNIVERSITAS MUHAMMADIYAH SURAKARTA

2018

VALIDATION SHEET

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SCIENTIFIC PUBLICATIONS

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NIK.664

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It has been approved in by Reviewer Council
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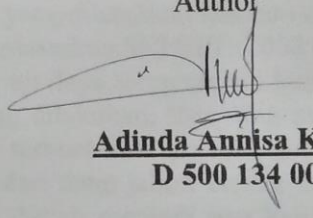

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Abstrak

Penggundulan hutan menjadi isu global saat ini. Penggundulan hutan disebabkan oleh banyak faktor, salah satunya adalah penebangan pohon oleh perusahaan tisu. Tisu banyak digunakan di dunia karena sangat praktis dalam pemakaiannya, tetapi masyarakat saat ini tidak menyadari efek dibalik produksi tisu. Bahan yang dapat digunakan sebagai pengganti pohon dalam pembuatan produksi tisu adalah limbah organik yang mengandung selulosa. Sebagian besar dari kita mengabaikan kemampuan dari limbah organik yang dapat diolah menjadi sesuatu yang bernilai ekonomi. Beberapa contoh limbah organik yang mengandung selulosa adalah batang pisang, daun jabon kering, serbuk gergaji kayu mahoni dan serbuk gergaji kayu sengon. Metode pada penelitian ini adalah *chemical pulping.* Setelah pulp terbentuk, dilakukan pencucian pulp, pemutihan pulp dan yang terakhir adalah mencetak tisu ke dalam bentuk lembaran. Tisu yang dihasilkan kemuan diuji untuk mengetahui kualitasnya. Uji yang dilakukan berdasarkan SNI 0103:2008 kertas tisu toilet. Uji yang dilakukan adalah uji gramatur, uji daya serap air, uji kenampakan, uji warna dan uji mudah hancur. Dari uji yang dilakukan, tisu yang mempunyai kualitas terbaik dan memenuhi standar SNI terbuat dari pelepah pisang. Tisu dengan kualitas yang kurang baik dihasilkan dari daun jabon kering. Sedangkan serbuk kayu mahoni dan sengon tidak dapat diolah menjadi tisu karena terlalu banyak mengandung lignin yang tidak bisa dihilangkan dengan metode *chemical pulping.*

Kata Kunci: tisu, batang pisang, daun kering, serbuk gergaji, *pulping*.

Abstract

Deforestation became a gobal issue right now. Deforestation is caused by many factors, one of them is tree logging by the tissue company. Tissue widely use in the world because it is very practice to use, but society nowadays does not realize the effects behind the tissue production. The material that capable to replace tree as raw material in tissue production is organic wastes that contain cellulose. Most of us are neglect the capability from those organic wastes that can be produce into something valuable. Some examples of organic wastes contains cellulose are banana stem, sawdust and dry leaf. The aim of this research are to know the influence of drying time, kinds of organic waste and bleaching agent to the quality of tissue. Organic wastes used in this research are banana stem, dry jabon leaves, mahogany sawdust and silk tree sawdust. The method in this research is chemical pulping method. After the pulp is formed the next step to do are wash the pulp, bleach the pulp and the last is form the tissue into sheets. The tissue is the tested to know its quality. The test is based on SNI 0103:2008 toilet tissue paper. The tests are grammage test, water absorption test, the appearance test, color test and degradation test. From the tests carried out, tissues that have the best quality and

passed SNI standards are made from the banana stem. Tissues with less quality are produced from dried Jabon leaves. While mahogany and sengon sawdust cannot be processed into tissue because it contains too much lignin which cannot be removed by the chemical pulping method.

Keywords: tissue, banana stem, drying leaves, sawdust, pulping.

1. INTRODUCTIONS

Banana stem fiber density is 1.35 g/cm^3, the content of 63-64% cellulose, hemicellulose 20%, lignin content of 5% and the average tensile strength of 600 MP (Wahyuni, 2015).

The content of mahogany and silk tree holocellulose is more than 65% and lignin content is 26.00% this makes mahogany are suitable as raw material for making pulp by using chemical and semi-chemical process (Gustan, 2005).

Red Jabon tree height can reach 40 meters with a round rod and perpendicular reached 70% - 80% with a trunk circumference reach more than 150 cm (diameter 50 cm). Jabon leaves content 10.13% of cellulose, 21.19% lignin and fiber 10.17% fiber (Wali, 2014).

Toilet paper are produced from pulp based on new cellulose fiber, recycled fiber or a combination of the two. The product classified according to properties such as softness, purity, high absorption capacity and strength.

Tissue making industries is the one of deforestation cause problem. Furthermore, the potential availability of using agricultural residues is more interesting despite of their limitations also to give economic value for waste material which potential to produce tissue such as banana stem, sawdust and dry leaf with chemical pulping process. The quality of the tissue should be suitable with SNI (*Standard Nasional Indonesia*) 0103:2008 (BSN, 2008).

The research of tissue manufacturing from organic waste, there are several various variable affecting its quality. Variable that affecting of the tissue quality are drying time, raw materials, bleaching, pulping, and the component of lignincellulose.

2. METHODS

Materials used was banana stem, abon dry leaf, mahogany sawdust, silk tree sawdust, H_2O_2 2%, NaOCl 2%, chitosan, tapioca, NaOH flakes, virgin coconut oil, and aquadest. Equipment used was beaker glass, bucket, drop pipette, filter, hotplate, magnetic stirrer, measuring fask, rubber bulb, mixer, stirrer glass, volume pipette, thermometer, watch glass, and oven. The methods of tissue making research was used chemical pulping. The procedure are drying, pulping, bleaching, sheeting or forming, and testing the quality of tissue based on SNI 0103:2008. The drying process was done by drying the raw materials in the oven with temperature 90^0C and variation time of 30 minutes, 60 minutes, 90 minutes, 120 minutes, and 150 minutes.

Chemical pulping process was used in this research. Dry raw material was placed into into beaker glass and add 750 ml NaOH 0.1 N. Heat the raw material up using hotplate as long as 90 minutes with temperature of 100^0C. The brown pulp has formed, washed the pulp, and let it dry completely. The dry brown pulp was placed in the beaker glass and add 500 ml H_2O_2 2% or NaOCl. Heat the brown pulp using hotplate for 60 minutes with temperature of 60^0C. The white pulp was then washed and filtered. Place the white pulp in mixer, add 4 ml of virgin coconut oil, 0.3 grams of chitosan, 0.3 grams of tapioca and 300 ml of aquadest. Pour the white pulp to the buckets with water. Form the pulp into thin sheets using flat horizontal filter 50 mesh in size. After that lift slowly, make it as thin as possible. Let it completely dry.

The tissue will be tested Based on SNI 0103:2008 toilet tissue involving grammage test, water absorption, appearance of the tissue containing of color test, crumbilty or degradation test in the water. The grammage test is a test to know the minimum weight of tissue. Minimum value is 14 g/m^2. The water absorption test is done by prepare the paper with a width of 15 mm and a length of at least 200 mm, hang the paper path perpendicular to the surface of distilled water with the other side is submerged as deep as 10 mm. After 10 minutes watch the absorption height in the tissue. The sheets appearance test, the tissue paper must be clean, soft and does not have hollow. To observe

tissue is done by see, touch and overlay the sheet. Degradation test, the test was done by insert the paper in water and shake or stir for approximately 60 seconds. Color test, the color of the tissue should not be faded, the test is done by soaking the paper in water for approximately 60 seconds, when the soaking water is colorless mean it does not fade.

Table 1. Quality requirements SNI 0103:2008 toilet tissue paper (BSN, 2008)

No.	Requirement	Unit	Parameters
1	Sheet		
	a. Appearance	-	Clean, soft and no hollow.
	b. Degradatiom	Second	Maximum 60
	c. Color	-	Does not faded
2	Grammage	g/m^2	Maximum 14
3	Water absorption, 10 minutes	mm	Minimum 30
Note: Tolerance value for grammage test ± 7 %.			

3. RESULT AND DISCUSSION

In this experiment, we want to know the influence of different variations of raw material, drying time and bleaching agent to the quality of tissue. Standard parameters of the tissue quality based on SNI 0103:2008 Toilet tissue paper.

3.1 Grammage Test

The grammage test is based on SNI 0103:2008, the maximum value of grammage test is 13 g/m^2. The result of the test is shown in the table 2 and figure 1. The less water content, the greater grammage value will get. the higher water content in raw materials, the lower the value obtained. This is because during the drying process, the raw materials that have a high water content, evaporation will also higher. Therefore, the longer the drying time of raw materials, the moisture content in the raw materials will also decrease, causing the higher grammage value obtained because softer and more adhesive the fibers (Apriani, 2016).

The bleaching agent does not affect anything to the grammage value. Banana stem has higher grammage value. This is caused by the fibers of banana stem are thicker or stronger than jabon leaves. Most of the banana

stem are higher than maximum grammage value. Mahogany and silk tree sawdust can not form tissue so, it can not be tested the grammage test. The mahogany and silk tree sawdust contain too much lignin which can not be removed by chemical pulping process.

Table 2. Result of Grammage Test from The Variation of Time and Raw Materials Based On SNI 0103:2008

No.	Drying Time (minutes)	Raw Materials (g/m^2)			
		Jabon Leaves NaOCl	Banana Stem NaOCl	Jabon Leaves H_2O_2	Banana Stem H_2O_2
1	30	4.2	14	11.1	13.6
2	60	4.6	16.7	12	15.4
3	90	5.5	19.3	13.3	16
4	120	6.5	20.4	13.8	19.8
5	150	7.8	24.7	16.5	23.3

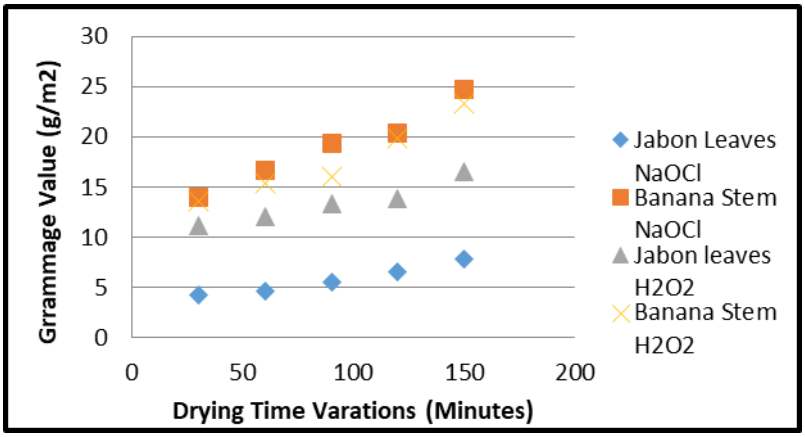

Figure 1. Result of SNI Grammage Test

3.2 Absorption Test

The longer drying time, it will be better at absorption. But, when the bleaching process did not do properly, it will caused the cellulose damage. The damage of the cellulose will impact to the quality of the tissue itself, for example the tissue absorption does not effective, the surface of the tissue will not as smooth as expected. Cellulose is one of the important elements that affected the tissue. The result is shown in the Table 2 and Figure 2. The water absorption rate between treatments is not significantly different, but there are some tends that occur in the testing of water absorption. The first tend is the

alkali concentration results in an increase in water absorption. This is due to the alkali that makes the cellulose structure swelling so, much free OH is available which causes the water absorption to increase (Khaswar, 2014).

Table 3. Result of Absorption Test from The Variation of Time and Raw Materials Based On SNI 0103:2008

No.	Drying Time (minutes)	Raw Materials (mm)			
		Jabon Leaves NaOCl	Banana Stem NaOCl	Jabon Leaves H_2O_2	Banana Stem H_2O_2
1	30	27	30	25	28
2	60	27	32	26	31
3	90	29	34	28	34
4	120	32	38	33	35
5	150	35	40	34	39

From all those variation of raw materials, mahogany and silk tree sawdust can not be tested. Those materials can not form tissue because the fibers can not be softened by chemical pulping process. There is too much ligning contain in the material and can no be removed. The fibers are too strong to be broken using mixer only. There should be use another process such as mechanical or semi-mechanical process.

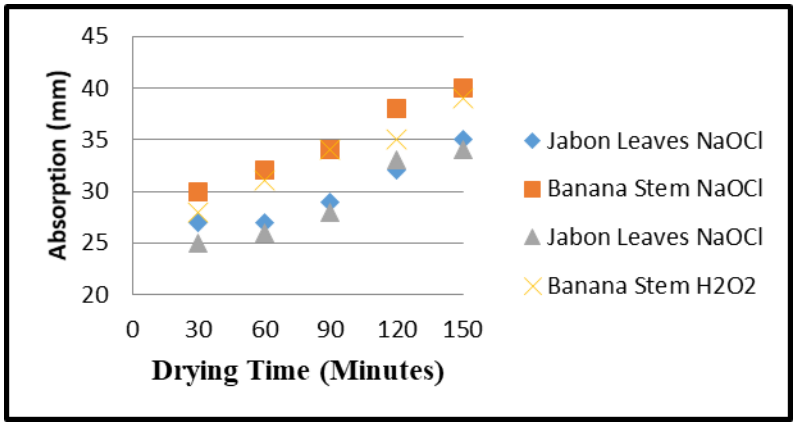

Figure 2. Result of SNI Absorption Test

3.3 Degradation Test

From the graphic below, the longer drying time process, the harder to degradation in the water. This is because the longer drying time the fibers will

more wrecked during the pulping process so, the tissue will be stronger because the fibers are also getting delicate and softer.

Table 4. Result of Degradation Test from The Variation of Time and Raw Materials Based On SNI 0103:2008

No.	Drying Time (minutes)	Raw Materials (second)			
		Jabon Leaves NaOCl	Banana Stem NaOCl	Jabon Leaves H_2O_2	Banana Stem H_2O_2
1	30	19	38	18	40
2	60	23	40	19	42
3	90	24	43	22	47
4	120	27	48	22	52
5	150	29	52	25	55

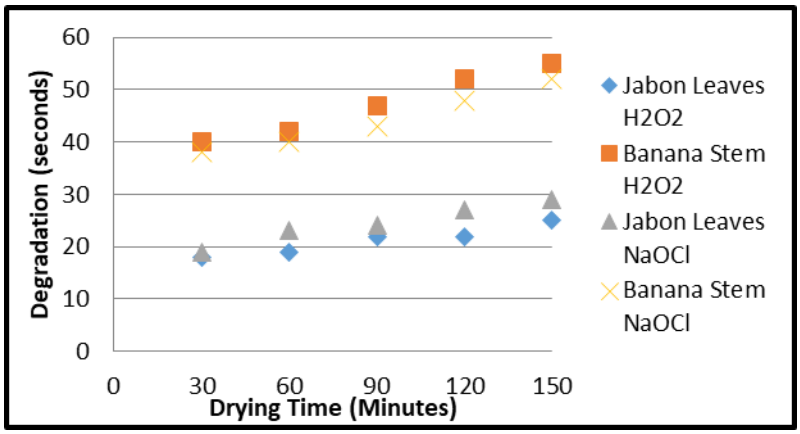

Figure 3. Result of SNI Degradation Test

3.4 Color Test

As a bleaching agent, hydrogen peroxide is more effective than chlorine or hypochlorite, however, it does have several advantages over these bleaching agents. Hydrogen peroxide causes less textile fiber damage, much gentler on fabric dyes, and does not have strong odor. Hydrogen peroxide removes the natural color of the raw material but, sodium hypochlorites could not remove the natural color of raw material effectively. Hydrogen peroxides is more environmetally frriendly because it can be dissolved in the water, wether chlorine can be dissolved in the water. Hydrogen peroxide is more expensive than NaOCl, that caused many industrial still use NaOCl as bleaching agent and choose to add some coloring agent such as white to make the product has

white or cleaner in color. No coloring agents added to all raw materials. So there is no faded color. The result can be seen in the table below.

Table 5. Result of Color Test from The Variation of Time and Raw Materials Based On SNI 0103:2008

No.	Drying Time (minutes)	Raw Materials (second)			
		Jabon Leaves NaOCl	Banana Stem NaOCl	Jabon Leaves H_2O_2	Banana Stem H_2O_2
1	30	No fade	No fade	No fade	No fade
2	60	No fade	No fade	No fade	No fade
3	90	No fade	No fade	No fade	No fade
4	120	No fade	No fade	No fade	No fade
5	150	No fade	No fade	No fade	No fade

3.5 Appearance Test

Table 6. Result of Appearance Test from The Variation of Time and Raw Materials Based On SNI 0103:2008

No.	Drying Time (minutes)	Raw Materials (second)			
		Jabon Leaves NaOCl	Banana Stem NaOCl	Jabon Leaves H_2O_2	Banana Stem H_2O_2
1	30	Less clean, soft, and no hollow	Less clean, softer, and no hollow	Clean, soft, and no hollow	Clean, softer, and no hollow
2	60	Less clean, soft, and no hollow	Less clean, softer, and no hollow	Clean, soft, and no hollow	Clean, softer, and no hollow
3	90	Less clean, soft, and no hollow	Less clean, softer, and no hollow	Clean, soft, and no hollow	Clean, softer, and no hollow
4	120	Less clean, soft, and no hollow	Less clean, softer, and no hollow	Clean, soft, and no hollow	Clean, softer, and no hollow
5	150	Less clean, soft, and no hollow	Less clean, softer, and no hollow	Clean, soft, and no hollow	Clean, softer, and no hollow

From all those raw material variation, the silk tree and mahogany sawdust can not formed tissue because the fibers are hard to be softened. There is so much lignin inside which can not removed by only chemical process. There should

be continue process for softening the fibers and removing the lignin. The chemical pulping process is not suitable with those materials.

4. CONCLUSIONS

1. The process is affecting the tissue quality, because different raw materials may be using different method. Chemical pulping is the right process for jabon leaves and banana stem but, for the sawdust waste should be using mechanical process. The best quality tissue toilet paper is from banana stem at 150 minutes drying time.
2. The longer drying time, the better quality will get. The tissue that pass the SNI standard is banana stem at 150 minutes drying time.
3. Hydrogen peroxide is more effective to bleach than sodium hypochlorite.

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